

## Industry Status

### *Macrobrachium* Culture Industry in Thailand<sup>5</sup>

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#### *Macrobrachium* species in Thailand

There are numerous freshwater prawns classified under the genus *Macrobrachium* which is generally categorized under the Family *Palaemonidae* Rafinesque, 1815, sub-family *Palaemoninae* Rafinesque, 1815. In Thailand, 19 *Macrobrachium* species that thrive in either freshwater or brackishwater, have been found and identified as follows:

Species	Freshwater	Brackishwater
<i>Macrobrachium amplimanus</i> (Cai and Dang, 1999)	Yes	No
<i>Macrobrachium dienbienphuense</i> (Dang and Nguyen, 1972)	Yes	No
<i>Macrobrachium equidens</i> (Dana, 1825)	No	Yes
<i>Macrobrachium eriocheirum</i> (Dai, 1984)	Yes	No
<i>Macrobrachium esculentum</i> (Thallwitz, 1891)	Yes	No
<i>Macrobrachium hirsutimanus</i> (Tiwari, 1952)	Yes	No
<i>Macrobrachium idae</i> (Heller, 1862)	No	Yes
<i>Macrobrachium lanchesteri</i> (de Man, 1911)	Yes	No
<i>Macrobrachium lar</i> (Fabricius, 1793)	No	Yes
<i>Macrobrachium latidactylus</i> (Thallwitz, 1891)	No	Yes
<i>Macrobrachium mirabile</i> (Kemp, 1917)	No	Yes
<i>Macrobrachium mieni</i> (Dang, 19750)	Yes	No
<i>Macrobrachium neglectus</i> (de Man, 1905)	No	Yes
<i>Macrobrachium niphanæ</i> (Shokita and Takeda, 1989)	Yes	No
<i>Macrobrachium rosenbergii dacqueti</i> (Sunier, 1925)	Yes	Yes
<i>Macrobrachium sintangense</i> (de Man, 1898)	Yes	Yes
<i>Macrobrachium sirindhorn</i> (Naiyanetr, 2001)	Yes	No
<i>Macrobrachium yui</i> (Holthuis, 1950)	Yes	No
<i>Macrobrachium</i> sp. (Cai, Naiyanetr and Ng, in press)	Yes	No

Of the nineteen species, below are the five species identified as the most economically important species for Thailand:

#### *Macrobrachium dienbienphuense*

Found in northeast of Thailand, *M. dienbienphuense* is distributed in the main rivers of Maekhong, Chi, Moon and their branches. The species has a moderate size, the biggest of which is about 6-7 cm. The prawns are being sold in the markets along the Maekhong and Moon rivers, particularly in Ubon Ratchathani Province. There is no developed culture technology for this species yet, may be because the prawn can still be captured in good quantities throughout the year from the natural waters.

#### *Macrobrachium niphanæ*

*M. niphanæ* has attractive characteristics with red brown spots lining around each of all the five pairs of walking legs. This prawn could pass as an ornamental aquatic species of economic importance. The species could be a subject for study for its biological details in order that an appropriate aquaculture system could be developed. This species is not well known to some people because it is found only in waterfalls and streams and very rarely in other watercourses and rivers.

<sup>5</sup>paper presented during the 1st Roundtable Discussion on the Development of Genetically Improved Strain of *Macrobrachium*, November 2003, Indonesia



### ***Macrobrachium lanchesteri***

*M. lanchesteri* is very similar to *M. niphanæ* in terms of size and morphology. The species is found in almost every inland waterbody and is very often found together with *M. niphanæ*. Because of its abundance, *M. lanchesteri* has become important to the local people in the rural areas. Many people like to eat the prawn even though its size is very small. In some provinces in northeast Thailand, culture of this prawn is usually done with fishes together in one pond for additional income.

### ***Macrobrachium sintangense***

*M. sintangense* is a species morphologically similar to *M. rosenbergii*. Its size is about the same as the immature *M. rosenbergii*. The biggest size of *M. sintangense* is about 8-9 cm. This prawn is also popular in the northeastern Thailand mainly because of its moderately large size which is just slightly smaller than *M. rosenbergii*. People in some areas call this prawn “Kung Kam Kram” which is the Thai term for *M. rosenbergii*. The prawn is sold in many provinces along the Mae Khong and Moon rivers. Due to the relative economic importance of the species, studies on its biology and life cycle should be conducted, so that appropriate aquaculture systems could be developed and the species could be introduced to the local fishfarmers.

### ***Macrobrachium rosenbergii dacqueti***

*M. rosenbergii* has been famously known as the “giant freshwater prawn” since 1958. It comprises two subspecies identified by the differences in some morphological characteristics and in particular their geographical distribution. One subspecies found in the Papuaasia area between Papua New Guinea and Australia, and the areas around the Philippines, is *M. rosenbergii rosenbergii* (de Man, 1879). The other species, distributed in the Indo-west Pacific from Indonesia to India including Thailand, is *M. rosenbergii dacqueti* (Sunier, 1925).

The following table compares the different characteristics of *M. rosenbergii dacqueti* and *M. rosenbergii rosenbergii*:

<b>Characteristics</b>	<b><i>M. rosenbergii dacqueti</i></b>	<b><i>M. rosenbergii rosenbergii</i></b>
1. Rostrum	part behind eye is convex, longer than scaphocerite	part behind eye is straight, as long as or shorter than scaphocerite
2. The second pair of walking legs	With large spines scattering, end of the spines straight	With small spines scattering, end of the spine horn-like
3. Distribution	India, Burma, Thailand Malaysia and Indonesia	Papuaasia and Philippines

In the past, the distribution of *M. rosenbergii* in Thailand was reported only in the brackishwater area connected to the sea. But now it has been found in many freshwater bodies of Thailand, especially in places where large numbers of the prawn have been released by the DOF (Department of Fisheries, Thailand) over the past decades. The species is highly economically important, particularly the big ones which are very expensive and popular as premium food. Many farms in Thailand, particularly in the central area, have done breeding and culture activities for this species as an industry for quite some time. However, the DOF of Thailand is still trying to improve its quality to include seeds, broodstock and products to successfully come up with the best prawn ever produced in the world.



## Giant Freshwater Prawn Production, Value and Area

It is a fact that the giant freshwater prawn (*Macrobrachium rosenbergii*) is one of the most important economic species in Thailand and in many Southeast Asian countries. An increasing local market demand has led to the overfishing of wild prawn stocks from natural waters every year. Hence, domestication experiments on the *Macrobrachium* have been conducted by the Department of Fisheries since 1956 to increase prawn production (Sidhimunka and Bhukaswan, 1982). This has prompted nationwide extension activities to disseminate the prawn culture technology to a number of commercial giant freshwater prawn farms. This species has now become one of the major economically important commodities in the Thai aquaculture industry.

The total prawn production in 2002 increased by 38% from 1996, with a corresponding Thai baht value increase of 89%. In terms of actual figures in 1996 and 2002, the total production were 7,200 and 10,000 metric tons, respectively, valued at 596.3 and 1,117.6 million Thai baht, respectively (Department of Fisheries and Suwannatos, 2003). The market price per kg (which varies according to the prawn sizes) has been increasing since 1989 (Table 1). In 1997, the large, medium and small sizes increased by 76%, 123% and 81% from those in year 1989, respectively (Table 1).

The freshwater prawn annual value and the annual production have increased during the past four years as shown in Figure 1. Most of the culture areas are located in the central part of the country. The total area devoted giant freshwater prawn culture in 2000 was 3926.9 ha, 69 % of which are in six provinces, namely: Ratchaburi (56%), Nakornpathom (13%), Supanburi (18%), Ayuthaya (3%), Karnjanaburi (6%), and Chachanksoa (3%).

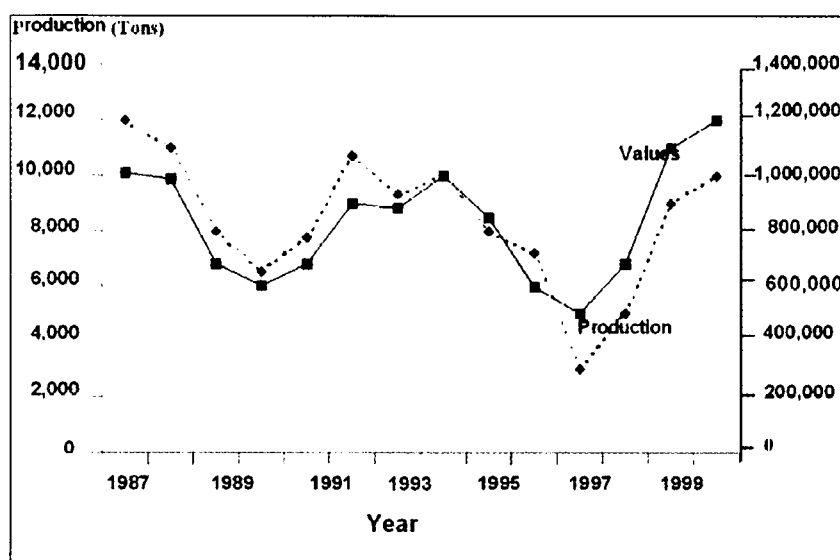


Figure 1. Production and values of cultured *Macrobrachium rosenbergii* in 1987-2000 (Department of Fisheries, 2001)

## Commercial Hatcheries

Domestication of the giant freshwater prawns in Thailand started in 1966 at the Songkhla and Bangkhen Fisheries Stations while small commercial hatcheries started to operate in 1973 (New, 1982 and Suwannatos, 2003). Giant freshwater prawn hatchery practices began to be developed in 1966, as early researches concentrated on larval rearing. As soon as the larval rearing practices were optimized, researches were subsequently focused on developing grow-out culture techniques.

Water quality was identified as a critical factor in larval rearing. Consequently, after several refinements in the rearing protocol, the optimum water quality conditions were established at 12 to 15 ppt for salinity, 27 to 31°C water temperature,



3-5mg/L dissolved oxygen, pH 7 to 8, and ammonia which should not exceed 0.1 mg/l (Colt and Armstrong, 1981; Suwannatos, 2003). Apart from water quality, quality seedstock production in commercial hatcheries also depend on many factors, namely: quality of parent stock, sexual maturity of female broodstock and hatchery management.

Table 1. **Price of farmed giant freshwater prawns between 1989-1997**  
(Department of Fisheries, 2001)

Price (in Thai Baht)									
Size	1989	1990	1991	1992	1993	1994	1995	1996	1997
Large	207.42	233.92	256.0	272.92	278.25	302.83	290.08	325.58	365.92
Medium	93.15	129.17	132.63	124.17	33.24	163.47	170.67	186.17	207.33
Small	49.97	62.51	63.08	66.34	65.62	69.65	72.83	71.03	90.83

Suwannatos (2003) reviewed the giant freshwater prawn rearing practices in Thailand, and pointed out four types of larval hatchery management. Each system had its own advantages and disadvantages. A number of researches have been conducted to develop these rearing systems to provide good quality seeds to the farmers and subsequently provide them the option for the type of hatchery system that will best suit their proposed site and resources.

#### ***Clear water system***

Simple and less expensive, this system could be applied in a small hatchery such as a backyard hatchery because there is no requirement for ponds. However, the hatchery manager should closely monitor the quality of the rearing water to ensure successful rearing operations. In cases where ponds are used, the size should be between 1-3 m<sup>2</sup> and 1.0 m deep.

#### ***Greenwater system***

This system was modified from a larval rearing scheme developed in Hawaii. A large number of quality seeds can be produced by rearing the larvae in greenwater containing the phytoplankton, *Chlorella* spp. The phytoplankton takes care of the disease problem and helps keep the water quality at an optimum pH level. However, this system requires a number of ponds and the rearing period is longer (more than 30 days) compared with that of the other systems.

#### ***Recirculation system***

This system is preferred for hatcheries that are far from the sea because it requires less seawater, and environmental conditions are easy to control. However, it is more costly than the other systems. Some researches that dealt with its development (Suwannatos, 2003), included the use of water treated with small weed organisms. Moreover, in this system, air circulation is optimized and the water continuously reused. Here, diseases and use of chemicals could be easily controlled. For this system, the hatchery manager should be well trained in water quality as well as on nutrition and disease management. Rearing period is also longer (more than 30 days) compared with that of the clear water system.

#### ***Earthen pond system***

A group of biologists at the Phetchaburi Coastal Aquaculture Station, Department of Fisheries developed a technology for rearing the larvae of giant freshwater prawn in earthen ponds (Tunsutapanich *et al.*, 1994). In this system, water quality in the earthen pond is maintained such that ecological balance can be achieved without any water change. The pond is installed with an air blower for consistent oxygen supply. Water chemical conditions are observed regularly and adjusted to suitable levels to keep the ecological system in the pond balanced.



The larvae are fed with natural zooplankton and *Artemia* nauplii. Although the system gives high juvenile survival rate, the rearing period to postlarval stage is longer than that of the other systems. The total production in this system is 5.1 million juveniles per 0.16 ha with an average survival rate of 88% (Tunsutapanich *et al.*, 1994). Here, the hatchery manager should regularly monitor water quality and maintain the ecological balance within the pond.

### Good Quality Seeds

Good quality seeds should result in high survival rate and fast growing juvenile prawn. The aforementioned hatchery systems when managed well, will be able to provide good quality seed supply to the *Macrobrachium* industry as long as the following measures are followed:

1. Suitable stocking density for larval rearing should be 20-40 post larvae/L
2. Temperature during the rearing period should range from 28° to 30°C
3. Sexually mature female breeders should be clean
4. Antibiotics should never be used
5. All equipment should be disinfected after every use
6. Good quality food such as *Artemia*, boiled eggs and pollock, should be used.

### Grow-out Culture

*Macrobrachium* culture in the country is now facing a number of problems such as slow growth, lack of appropriate broodstock management schemes and diseases. To counteract these problems, commercial *Macrobrachium* farms developed an improved strain using new farming management methods. The strain has been initially introduced to the farmers, but later the private hatcheries have developed their own freshwater prawn selective breeding programs.

*Macrobrachium* farming in Thailand has been classified into two types: the traditional farms growing the local strain, and the *Macrobrachium* farms using the new strain. Traditional farms usually consist of small number of 0.32-0.96 ha earthen ponds stocked with prawns at 5 to 20 juveniles/m<sup>2</sup>. The farmers prepare their own feeds. During the first month, the prawns are fed twice a day at 30-40% of the body weight. During the third month of rearing, the feeding rate is gradually reduced to 5%, and finally to 3% from the fourth month onwards. At six months, large-sized prawns are seined and sold while the small ones are left for on-growing in the culture pond. The marketable sized prawns are from 50 to 100 g/pc (Tookwinas, 2002).

Mr. Supon Sovanapreecha, owner of the Kasetsoambuond Farm in Supanburi Province, has been operating his farm for three years using the new strain of *Macrobrachium* (interviewed in Thai Fisheries Gazette, 2002). The juveniles are reared in the nursing pond at 75 pc/m<sup>2</sup> for two months, after which these are stocked in the grow-out pond at 7-15 pc/m<sup>2</sup>. After four and a half months, the female prawns averaging 25-33g are culled and sold. On the sixth month, the large males (100-125g) are harvested and sold. The total production of the first generation is usually about 3,750 kg/ha with a sex ratio of 80% males to 20% females. However, production usually decreases by 10% in the second and third generations (male size: 83g). Therefore, the development of a selective breeding program to improve the growth of the domesticated *Macrobrachium* strain has been recognized as an urgent concern for the freshwater prawn industry.



### **R&D efforts on quality improvement of *M. rosenbergii dacqueti***

Several research studies that support efforts for the improvement of the quality of the giant freshwater prawn have been implemented. Below is a summary of each of the study.

#### ***Genetic differentiation and population structure studies***

**Yaitavorn P. 1989. Mitochondrial DNA variation in giant freshwater prawn (*Macrobrachium rosenbergii* de Man). M.Sc. Thesis, Chulalongkorn Univ., Bangkok, Thailand**

A study on genetic variation in natural population of giant freshwater prawn *Macrobrachium rosenbergii* de Man was undertaken to identify prawn stocks in different locations of Thailand. The study was based on the analysis of the mitochondrial DNA (mtDNA) variation restriction fragment length polymorphism. It showed significant difference in the restriction fragment length polymorphism (RFLP) patterns of mtDNA between prawn from two rivers. The prawns from Bangpakong showed strong discrete band at 1.1 kb but those from Kraburi showed the band at about 0.7 kb. By using this clone, the RFLP patterns of Bangpakong River and that from Kung Kam Thong Farm, both of which are in central Thailand, were found similar.

**Sodsuk S, PK Sodsuk. 1998. Genetic diversity of giant freshwater prawn from three locations of Thailand. Technical Paper No. 18/1998. National Aquaculture Genetics Research Institute, Department of Fisheries, Thailand**

Giant freshwater prawn (*Macrobrachium rosenbergii* de Man) from three locations of Thailand (Chachoengsao, Surat Thani and Songkhla) was identified using allozyme electrophoresis. A total of 24 enzyme loci were detected from pleopod, muscle and hepatopancreas. Three loci, GPI\*, MPI\* and PGM-1\*, were found to be polymorphic ( $P 0.95 = 0.125$ ). No significant differences from Hardy-Weinberg equilibrium were observed within any single population. Mean expected heterozygosity ( $H_e = 0.031 \pm 0.018$ ) for the species was found to be relatively low. Inbreeding coefficients (F-statistics), polymorphic loci differences, genetic distances between populations and dendrograms showed that all three populations were the same single population based on allozyme marker analysis.

**Vanavichit A, et al. (pers. comm.) Agricultural Genetic Engineering and Biotechnology Center, Kasetsart Univ. Research and Development Institute, Kamphaengsaen Campus, Nakhornpathom, Thailand**

Genetic differentiation among six populations (Bangpakong River, Nakhorn Nayok River, Tapi River, Songkhla Lake, Kraburi River and Yaephew River) *Macrobrachium rosenbergii* de Man was carried out. The study was based on mtDNA analysis of 12S rDNA and 16S rDNA genes, that had been cut with four restriction enzymes, Alu I, Dra I, Hinf I and Tru9 I. Based on genetic distances, two major populations of the prawns were identified. One major population consisted of prawns from all water-bodies in Thailand, the Bangpakong, Nakhorn Nayok, Tapi and Songkhla, and another 63.46% of the prawns from Kraburi. The other major population included 65.46% of the prawns from the Yaephew in Myanmar. Genetic distance between the two major populations was 0.931. The remaining prawns from the Kraburi and Yaephew were mixed together as another intermediate group.

#### ***Selective breeding programs***

**Meewan M. 1991. Morphological inheritability and growth of giant freshwater prawns. M.Sc. Thesis, Asian Institute of Technology (AIT), Thailand**

An experiment to estimate the heritability of growth in relation to morphotypic transformation among full- and half-sib families of the freshwater prawn, *Macrobrachium rosenbergii* was undertaken. Heritability estimates were made on the progeny from 32 full and half-sib families nested within eight sires with two dams per sire. The heritability estimates on the carapace length based on paternal, maternal and full-sib



analyses were found to be the highest  $0.40 (\pm 0.22)$ ,  $0.13 (\pm 0.07)$  and  $0.26 (\pm 0.11)$  at 23 weeks, respectively. The heritability on morphotypic transformation at 31 weeks from orange claw males (OC) to blue claw males (BC) were  $0 (\pm 0.04)$ ,  $0.73 (\pm 0.08)$  and  $0.37 (\pm 0.02)$  and the morphotypic transformation from small males (SM) after removing bulls were  $0.21 (\pm 0.06)$ ,  $0.56 (\pm 0.05)$  and  $0.39 (\pm 0.03)$  for paternal, maternal and fullsib analyses, respectively. The survival rate in the cage culture of initial stock to 23 weeks ranged from 55% to 96%. The number of females in every cage was greater than male and blue claw males at 23 weeks. The resulting heritabilities implied the possibility for trait improvement.

**Rattikansukha C. 1993. Intraspecific hybridization in *Macrobrachium rosenbergii* de Man. M.Sc. Thesis, Chulalongkorn Univ., Bangkok, Thailand**

An intraspecific hybridization of two *Macrobrachium rosenbergii* populations, using the reciprocal crosses of prawns from Kraburi and Chao Phraya rivers was carried out. Results indicated that the postlarvae obtained from the Kraburi x Kraburi crosses were significantly larger than those from the Chao Phraya x Chao Phraya crosses while hybrids of the two populations did not exhibit any heterosis.

**Uraiwan S, S Sumanojitraporn, K Ampolsak. 2002. Genetic improvement to increase growth rate of giant freshwater prawn (*Macrobrachium rosenbergii* de Man) : heritability estimates and within-family selection. The Proceedings of 40th Kasetsart University Annual Conference. 632-640 pp**

Sib analysis and selection procedures were designed to estimate heritability and realized heritability on growth rate of *Macrobrachium rosenbergii*. Under cage culture conditions, heritabilities were estimated from 16 full-sib and 8 half-sib families using nested analysis of variance model. Heritabilities of length and weight of male and female prawns five months old were  $-0.081 \pm 0.014$  and  $0.122 \pm 0.074$ , and  $0.060 \pm 0.054$  and  $0.030 \pm 0.041$ , respectively.

Under pond conditions, heritabilities of length and weight of six-month old male and female prawns were  $0.156 \pm 0.077$  and  $0.142 \pm 0.096$ , and  $0.254 \pm 0.080$  and  $0.272 \pm 0.210$ , respectively. The realized heritabilities in the male and female prawns after one generation of within-family selection were 0.331 and 0.058, and 0.745 and 0.395, respectively. After one generation of selection for large size, female prawns of the six month old selected line 6 were significant ( $p < 0.01$ ) six and 12% larger by length and weight than those of the control line, respectively. Similarly, six-month old selected female prawns were significantly ( $p < 0.01$ ) 5 and 16% larger by length and weight than those of the parental line. The results showed that genetic improvement to increase growth rate of the *Macrobrachium rosenbergii* is possible.

**Uraiwan S, S Sumanojitraporn, K Ampolsak, S Jeenmik. 2003. Response to within-family selection on growth rate of freshwater prawn (*Macrobrachium rosenbergii* de Man). The Seminar on Fisheries 2003. 7-9th July 2003, at the Department of Fisheries, Thailand**

A selective breeding program to improve growth rate of giant freshwater prawn (*Macrobrachium rosenbergii*) was carried out at the Aquatic Animal Genetics Research and Development Institute from 1998 to 2000. Within family selection procedure was applied to improved the growth rate of cultured prawns. The experiment consisted of two lines including a high growth selected line and a control line. Selection responses were estimated after one generation of selection. Female prawns of the selected line at 20 weeks old were ( $p < 0.01$ ) 4 (12%) and 5 (20%) significantly larger by length and weight than those of the control line and their parent generation, respectively. Male prawns of the selected line at 20 weeks old were ( $p < 0.01$ ) 5 (18%) and 7 (14%) significantly larger by length and weight than those of the control line and their parent generation, respectively. The estimated realized heritability at one generation of selection was moderate. The average heritability in length and weight at 20 weeks old were 0.38 and 0.22, respectively. The results of this experiment showed that within-family selection is an efficient procedure to improve growth of the giant freshwater prawn.



### ***Management procedures, domestication selection***

**Doyle RW, S Singholka, MB New. 1983. "Indirect selection" for genetic change: a quantitative analysis illustrated with *Macrobrachium rosenbergii*. *Aquaculture* 30 : 237-247**

The term "indirect selection" means selection, which is exerted on a trait by methods other than deliberate artificial selection for the trait itself. It includes selection, which may be an incidental by product of harvesting and breeding techniques, as well as correlated selection on a trait caused by artificial selection on another trait. Statistical models are derived for calculating the intensity of indirect selection in aquaculture environments. The calculations are illustrated with growth rate data on *M. rosenbergii* from prawn ponds in Thailand, and with computer-generated data, which simulate measurements made during a multiple mark-recapture experiment. Indirect selection for growth is probably negligible in Thai prawn farms and hatcheries at present, but small changes in management practice could exert strong indirect selection on growth rate. Control of indirect selection may be useful for the genetic improvement of aquaculture stock, especially in developing countries and other situations where an intensive artificial selection program is not economically or biologically desirable. Like all selection programs, the probability of success is critically dependent on the genetics of the traits being selected.

**Doyle RW. 1983. An approach to the quantitative analysis of domestication selection in aquaculture. *Aquaculture* 33 : 167-185**

Domestication selection is defined as natural selection on traits, which affect survival and reproduction in a human-controlled (domestic) environment. By altering various aspects of the environment, domestication selection can be made either to augment or to oppose artificial selection on traits of commercial importance. An example has been shown on the effects of selection on growth in *Macrobrachium rosenbergii* associated with variable development rate and age-at-harvest. It is concluded that management procedures can have strong selective effects and that genetic changes (for good or ill) may be expected to occur rapidly if the obvious genetic conditions are met.

### ***Biotechnological approaches to genetic improvement***

**Vanavichit A, *et al.* (pers. comm.) Agricultural Genetic Engineering and Biotechnology Center, Kasetsart Univ. Research and Development Institute, Kamphaengsaen Campus, Nakhornpathom, Thailand**

All-male production is one method for the aquaculture stock of *Macrobrachium rosenbergii* to be more effective, because normal male prawns (zz) grow much better than the normal females (zw) especially in the first six months of culture. The method for all-male production includes sex-chromosome manipulation based on sex reversal to female using female synthetic hormone. The procedure also needs development of molecular or DNA marker which is a sex-linked marker to be used for selecting the right neofemale prawn, carrying the male zz-chromosomes, to mate with a normal male, also carrying the zz-chromosomes. Consequently, all progenies obtained should be all-male with zz-chromosomes, of which each half should come from the mother (neofemale) and from the father (normal male).

**Klinbu-nga S. (pers. comm.) Marine Biotechnology Research Unit, National Center for Genetic Engineering and Biotechnology (BIOTEC), based in Chulalongkorn University Campus Bangkok, Thailand**

Klinbu-nga (pers. comm.) has also been searching for sex-specific DNA markers in *Macrobrachium rosenbergii* using AFLP technique. He claimed that five male-specific markers and four female-specific markers have been found. Further to this, he has been doing more advanced research by examining the expression of genes at terminal ends of the vas deferens and oviducts of male and female prawns, respectively using the RAP-PCR technique. Markers expressing specifically the small claw males (340 bp) and the females (415 bp) have been found. All of the DNA markers found have been cloned and will be tested for the sex-specificity.





**Sagi A, ED Aflalo. 2003. The androgenic gland and monosex culture in prawns-biotechnological perspective. Department of Life Sciences and the Institute for Applied Biosciences, Ben Gurion Univ. of the Negev, Beer Sheva, Israel**

Males of the freshwater prawn, *Macrobrachium rosenbergii*, grow faster and reach a larger size at harvest compared to females, making the culture of monosex all-male population advantageous. Sexual differentiation in crustaceans is regulated by the androgenic gland (AG) found to be exerting morphological, anatomical, physiological and behavioral effects. The AG plays a pivotal role in the regulation of male differentiation and in the inhibition of female differentiation. In *M. rosenbergii*, complete sex reversal was achieved by AG removal in immature males, resulting in female differentiation, including the development of ovaries, oviducts and female gonopores. Similarly, AG implantation into immature female leads to the development of testes, sperm ducts and male gonopores. *M. rosenbergii* that had undergone sex reversal proved to be capable of mating with normal specimens and producing progenies. Early attempts to culture all male populations through manual segregation were reported from Israel and recently from India and other countries.

### Future Plans and Prospects

The National Thailand Research Fund in cooperation with the Department of Fisheries conducted a workshop on the "Participation of increased effort in *Macrobrachium* industry" on 20 August 2003. The main objective of the workshop was to discuss the aspects of increased efficiency in producing *Macrobrachium rosenbergii* as a new premium aquaculture commodity. Problems and plans on the different aspects, e.g. nursery, grow-out culture, nutrition, diseases and genetics, were discussed. The Department of Fisheries proposed to develop a selective breeding program to improve the economic traits of the *Macrobrachium rosenbergii* cultured in Thailand. In addition, researches to develop a practical farm management protocol for each part of the country were also planned.

As *Macrobrachium rosenbergii* is now becoming a premium aquaculture commodity, good production processes from the farm to the table should be established. Therefore, a code of conduct (CoC) is planned for *Macrobrachium*, similar to the one adopted for the country's marine shrimp culture industry. The planned guidelines of the CoC for *Macrobrachium* should include the following aspects (Tookwinas *et al.*, 2002 and Tookwinas, 2002):

- (1) suitable site selection
- (2) general pond management
- (3) stocking density
- (4) feed management
- (5) prawn health management
- (6) therapeutic agents and other chemicals
- (7) effluents and solid waste management
- (8) harvesting and selling
- (9) social responsibility
- (10) farmer association and education
- (11) data collection



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